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Assessment of post-harvest handling and quality of honeybee products along the value chain in SNNPR, Ethiopia

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Abstract
This study was conducted with the objective of identify post-harvest handling practice along different value chain actors of honey, major post-harvest handling problems of honey and honey products, evaluate Physical and chemical composition of honey and honey products along different value chain actors and characterize adulterant materials of honey and beeswax. The total of 120 beekeeper respondents were participated to gathered primary data regarding to honey production system, Constraints of honey and honey product handling, processing and marketing, honey harvesting and processing, honey harvesting materials, adulteration, extent of adulteration and adulterant materials of honeybee products and 45 honey samples were collected and analyzed to understand physiochemical characteristics honey were: color, moisture content, reducing sugar, sucrose, glucose, maltose content, acidity, hydroxyl methyl furfural (HMF), mineral content, pH and pollen analysis. All parameters were analyzed following the techniques proposed by the Codex Standard for Honey. A statistical analysis using SPSS 20 descriptive, frequency and Pearson correlation test of physicochemical properties of honey interdependent. Shortage of available bee forages, predators, pests and diseases were major constraints of honey production whereas market linkage problem, low price of honey, skill gap to process honey and beeswax. 67.5% of respondent beekeepers mostly used locally available material bottle gourd/"kill"/ to stored their honey in the study area. Mean moisture content, Ash content, honey acidity, electrical conductivity, pH value, HMF, fructose, glucose, sucrose, maltose, F/G ratio, G/water ratio of honey was 19.75, 0.18, 33.97 meq kg−1, 0.41 mS.cm-1, 3.45, 3.78 mg/kg and 34.61%, 30.91%, 1.96%, 1.36%, 1.13 ± 0.12 and 1.57±0.18 respectively.

Keywords: honeybee, honey quality, physicochemical, property, post-harvest handling

Introduction

Honey is the natural sweet substance produced by certain species of bees, from the nectar of plants, from secretion of living part of plant. The bee collect this sugary substance of their own, deposit, reduce the water content, store and leave it in honey combs or honey pots to ripen and mature for their own consumption (Codex Alimentarius, 1989) [14]. Ethiopia is believed to possess high potential in producing honey. It is almost exclusively used for local consumption, and to a very large extent used for brewing of mead, locally called '*Tej*'. There is no wedding or other cultural, religious and social events can be imagined without the honey wine '*Tej*'. Ethiopia is currently ranked as the largest honey producer in Africa and the third largest worldwide by producing 45,300 tons of honey in 2010 (FAOSTAT, 2012) [16]. Also she has diverse habitat and flora for honeybees (Mohammed *et al*., 2006) [23]. Production and supply of honey by regions shows that Oromia accounts for over 55% of the bee colonies and 53% of the Honey production, followed by Amhara which accounts for about 20% of the colonies and 21% of the honey production. The Southern Nations, Nationalities Peoples Regional State, on the other hand, accounts for about 15% of the bee colonies and 17% of the honey production (Ayalew K., 2008) [8].

Moreover the honey produced in Ethiopia is expected to become a major commodity for acquiring foreign currency to improve the Ethiopian economy. Although Ethiopia does not have sufficient infrastructure for transporting and storing goods, the long shelf life of honey makes it an attractive export for the country. Besides these, there is low quality standard. Many post-harvest treatments as a result of poor containers, storing room conditions, and many other ingredients mixed in are among some to mention.

Honey is composed primarily of the sugars, glucose and fructose while its third greatest component is water. It also contains numerous other types of sugars, acids and minerals. The sugars found in honey can be classified as monosaccharide (glucose, fructose), sucrose and oligosaccharides (White, 1980) [26].

The quality of honey for example is affected by different factors from the time it is removed from the honeybee colony until it is sold for human consumption (Keystone 2002, Sanz ml *et al.*, 2003). Honey should have any objectionable matter, flavor, aroma, or taint absorbed from foreign matter during its processing and storage. No pollen or constituent particular to honey may be removed except where this is unavoidable in the removal of foreign inorganic or organic matter.

Even if beeswax is a non-perishable product the way it is processed and handled has a great influence on its quality, quantity and marketing. In the export market the issue of quality products is very important. To become competent both in local and export markets the quality and quantity of the beeswax has to be maintained. Processing and marketing of beeswax by producer's cooperative and small-scale processor have been successfully used in many tropical countries. In Ethiopia due to

lack of efficient beeswax processing methods, rendering of hand extraction method is contributing for loss of significant amount of beeswax.

The quality and quantity of crude beeswax is affected due to handling and processing method. This is may be due to sources and pre and post-harvest handling conditions. The quality of beeswax is judged from its color, purity and uniformity. Light color beeswax has the greatest value in world market. Hence it is paramount important to evaluate the quality of beeswax obtained from different sources. It is based on this background that this study is initiated with the following objectives:

Now a day's honey is becoming adulterated with different ingredients. Adulteration due to relative high price of honey; therefore, this illegal practice has become more and more attractive to producers (Nuru A., 1996, Nuru A., 1999) [21]. It is a well-known problem and many methods of analysis are available to detect falsification with various types of sugars and with inexpensive sugar syrups.

By carrying out the usual chemical determinations, such as the glucose, fructose, sucrose and hydroxyl methyl furfural (HMF) content and the diastase index, these adulterations of honey can easily be detected (Codex, 1989; Martin, *et al.*, 1998) [14, 11]. High levels of HMF (greater than 100 mg/kg) can also be an indicator of adulteration with inverted sugars. Cane sugar or sucrose is "inverted" by heating with a food acid, and this process creates HMF. Many food items sweetened with high fructose corn syrups, e.g. carbonated soft drinks, can have levels of HMF up to 1,000 mg/kg (White, J. W., 1992) [25]. However, in many developing countries a laboratory for the above-mentioned routine analyses is not always available. However, by simple microscopic analysis it is possible to detect adulteration of honey with cane sugar and products derived from cane sugar (White, J. W., 1992) [25].

These days, hive products adulteration, an illegal practice, is a cross cutting problem all over the world especially in developing countries. This illegal practice is greatly affecting the quality and marketing of honey and honey bee products. This has been confirmed by numerous reports from different corner of the country at all stages. Therefore, assessment of the extent, identification of materials and actors involved and characterization of adulterated hive products and information availability regarding major techniques used for identification with valuable information provision to quality control mechanisms are paramount importance.

Objectives

General Objective

- To assess post-harvest handling practice and quality of honey products

Specific objectives

- To identify post-harvest handling practice along different value chain actors
- To identify major post-harvest handling problems of honey and honey products
- To evaluate Physical and chemical composition of honey and honey products along different value chain actors
- To identify and characterize adulterant materials of honey and beeswax

Material and Methods

Study area Description

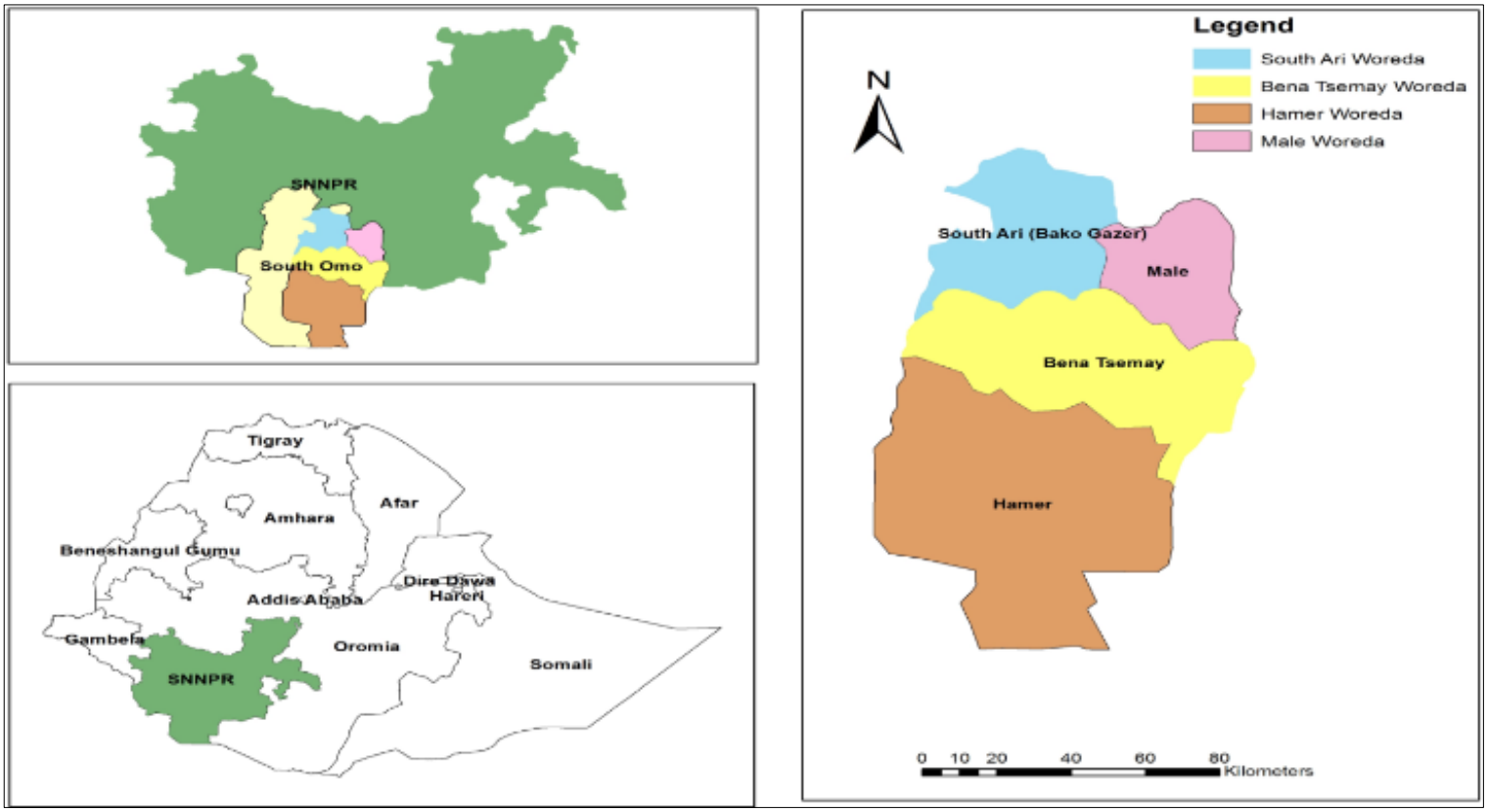

Fig 1: Map of study areas

Data collection

Survey (Phase 1)

Both primary and secondary sources of data were used in this study. Secondary data were obtained from reports of woreda Agricultural Development Office, Zonal Agricultural Department Office, Regional Bureau, NGOs and other published and unpublished materials. Primary data were collected through semi-structured questionnaire, informal discussion and key informants (survey on beekeepers, cooperatives, collectors and retailers). Direct observations were also have been used.

The Participatory Rural Appraisal (PRA) was used to generate information during rapid survey. Based on the information generated through PRA, the questionnaire and record sheets have been developed for the formal interview/main survey. The enumerators were researcher's direct contact with beekeeper respondents.

Under this phase purposive and multistage sampling procedure were employed to select respondent beekeepers. Accordingly, from South Omo zone, three Districts namely Benatsemay, Mallee and Debub Ari Districts have been selected using purposive sampling based on their potential honey market places and suspected areas for honey adulteration. The data's to be gathered were

- Constraints of honey and honey product handling, processing and marketing
- Honey harvesting frequency and period
- Method of honey harvesting and processing
- Honey harvesting materials
- Adulteration, extent of adulteration and adulterant materials of honeybee products
- Marketing areas for honey and honey products
- Price of honey and honey products

Laboratory Analysis (Phase 2)

Honey samples with the volume of 0.5 kg were collected at each representative sample areas of South Omo Zone Districts namely Debub Ari, Mallee, Benatsemay and Hamer. The samples were collected from each of the beekeepers, collector and retailer, from farm gate and market places in the study areas. The totals of 45 honey samples were collected from the above actors.

Fig 2: Collected honey samples from the study area

Purposively adulterated honey with the materials obtained from the survey were prepared and the status of pollen count and other relevant physicochemical analysis of pure (unadulterated) honey and the purposively adulterated honey were conducted using appropriate mellissopalynological procedure of pollen analysis and were used as a reference. Then pollen analysis were done for each sample collected from each of the representative sample areas at different stages and these results were compared with the bench marks, to determine whether it is adulterated or not regardless of the materials used for adulteration. Additionally, taste, aroma, color and viscosity of the adulterated honey will be characterized in such a way that consumers were able to identify. The collected samples were analyzed in collaboration with Holleta bee research center laboratory.

Under the laboratory, physicochemical composition (moisture content) and chemical compositions (pH, acidity and mineral, HMF, reducing sugar and sucrose content, electrical conductivity, ash contents and pollen of the honey samples) were determined according to the Harmonized Methods of the International Honey Commission (Bogdanov, 2002) [12] and Geremew (2005) [18].

Data management and Analysis

Statistical analysis was carried out using SPSS 20 Descriptive and frequency. Pearson correlation analysis was conducted to determine the associations between the physical properties of honey.

Result and Discussion

Major constraints of honey production

Production constraints

The current study revealed that in the study area shortage of valuable honey bee forages (55%) due to expansion of farm land, Predators attacking mainly monkeys (29.2%), honey bee pests and diseases (1.7%), knowledge gap to use improved beekeeping technologies also factors that have been affecting honey production and productivity.

Post-harvest constraints

During the study period honey producer beekeepers listed such post-harvest constraints like market linkage problem, Skill gap to strain honey and beeswax production and processing, Low costs of honey during harvesting season as well as during off season, inaccessible of market information due to these buyers have chance to set price of honey during that particular market day.

Honey harvesting and Post -harvest handling practice

The frequency and amount of honey harvested varied depends on flowering condition of major bee forages, honeybee colony management practices and number of beehive Kajobe R. *et al* 2009. In the study area there were two times honey harvesting season in a year agree with CSA, 2016 [15], major honey harvesting periods were December and April it depends on whether condition/rainy season/ of the season and from July to August where minor honey harvesting periods correlate with availability of moisture and peak flowering period. During honey harvested, beekeepers cut and pull the fixed combs one by one and then pollen, brood and honey combs were removed and kept in locally available container called bottle gourd/*"kill"/* which have narrow entrance mouth and wide body size, honey producer beekeepers after fill of the container with honey they have sealed the honey container with the mixture of cattle dung and ash until they sold honey.

67.5% of the respondents were used bottle gourd/"kill"/ to stored honey and transporting to the market and 30.8% used both plastic jar and bottle gourd/"kill"/ whereas only 1.7% respondents used plastic jar as shown in Table 1. Collectors were used plastic jars, fertilizer bags and bottle gourd/"*kill"*/ as observed in Fig 2. The respondent beekeepers sometimes store their honey 1-12 months due to cheapest price of honey during harvesting season.

Table 1: honey harvesting and post-harvest handling practice

Parameters	Variables	Frequency	percent
Frequency of harvesting in a year	two time	120	100
Major honey harvesting season	December	75	62.5
	April	45	37.5
Minor honey harvesting season	August	84	70.0
	July	36	30
Materials used to stored honey	plastic jar	2	1.7
	bottle gourd/kill/	81	67.5
	Both plastic jar and kill	37	30.8

Fig 3: Handling and marketing of honey in the study area

Processing of honey and bees wax

According to our research result 100% of respondent beekeepers cannot be strain honey or processed their honey due to these they have been selling raw honey rather value addition. On the other hand there were also limited of beeswax collecting and processing practices in the study area at home level.

The current study revealed that, factors that affecting of strain honey, beeswax collecting and processing were lack of knowledge and awareness.

Table 2: processing of honey and beeswax

Parameters	Variables	Frequency	percent
Trends of honey straining practice	No	120	100.0
Beeswax collection and processing at home	No	120	100
Factors affecting collecting of beeswax and processing	lack of knowledge and awareness	120	100.0

Marketing of honey and beeswax

In Ethiopia, honey and beeswax is one of the important exportable agricultural commodities which are produced in many parts of Ethiopia. In the study area honey marketing price was too cheap during the study period. As observed in Table 3 the price of crude/unstrained/ honey during harvesting season were ranges between 40-60 ETB Birr/Kg in average 50.25 ETB Birr, whereas price of crude honey during off season were ranges between 50-70 ETB Birr/Kg in average 62 ETB Birr which means during off season honey marketing price somewhat good for producers when they stored their honey keeping safe in hygiene.

According to the current study result traders where the most honey buyers from honey producer beekeepers followed by retailors, local collectors, "Tej" brewers and local consumers as shown in Fig 3.

Table 3: price of honey

variables	N	Minimum	Maximum	Mean	Std. Deviation
Price of crude honey during harvesting season/ETB Birr?	120	40.00	60.00	50.2542	4.56891
price of crude honey during off season/ETB Birr/	120	50.00	70.00	62.0598	5.02286

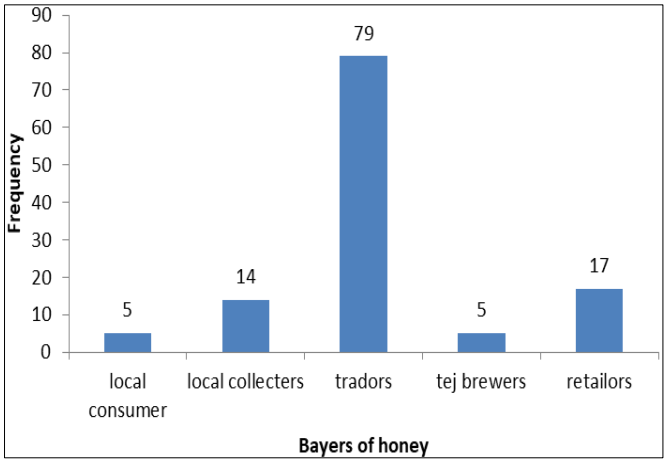

Fig 4: buyers of honey

Adulteration of honey and bees wax

The current study revealed that 100% of respondent beekeepers were implies that here is no adulteration of hone intentionally in the study area, but in traditional way of honey handling practice might be leads to poor honey quality. Even the respondent beekeepers couldn't understand what adulteration materials added in the honey, but sometimes beekeepers added dry honey combs to honey during honey harvesting complained by traders. Since there were no trends of collecting and processing of beeswax in the study area the current study excluded beeswax quality analysis.

Physic-chemical properties of honey

Moisture content of honey

Moisture content is one of the most important parameter to be considered in the quality of honey. Honey is an excellent hygroscopic product and has tendency to absorb atmospheric moisture and thus readily increase its moisture levels. Further, the moisture levels may also largely depend on methods of harvesting and extraction of honey which may differ from location, species and practices Bogdanov S. *et al* 1999 [11]. The overall mean moisture (% by mass) content of honey in the study area was (19.75) which were found between the range of national and international standard limit. The present results agree with results of Bekele Tesfaye *et al* 2016 [9], Nuru Adgaba 1999 [31], Tadesse Belie 2009 [23], that reported 18.8%, 20.5%, 18.8% respectively as mean test result for Bale honey, Ethiopian honey and from Burie District of Amhara Region. Most of honey samples (64.44%) moisture content between 19-20(Table 4) which were statistically not significant at (P>0.05), on the other hand there was variation of moisture content by type of honey sample and honey sample location as shown in (Table 4), but statistically there were no significant variation (P>0.05) between sample from farmer and merchants as well as samples from Hammer, Benatsemay, Mallee and Debub Ari Districts.

Table 4: chi-square(x^2) test of moisture content in ranges, sample type and sample location

Variables(Risk factors)	Moisture content	N	N%	X^2	P-VALUE
Moisture content range	17-18	7	15.55	37.75	.000
	19-20	29	64.44		
	21-22	5	11.11		
	23-24	4	8.88		
Type of honey sample	Farmer(19.20)	25	55.6	.556	.456
	Merchant(20.45)	20	44.4		
Honey sample location	Hamer(19.37)	8	17.8	6.644	.084
	Benatsemay(19.43)	16	35.6		
	Mallee(19.33)	6	13.3		
	Debub Ari(20.71)	15	33.3		

Ash content of Honey

The ash percentage found in honey expresses its richness in mineral content and constitutes a quality parameter. In this study, it can be seen that honey from the study area showed 0.18 mean ashes percentage below the allowable maximum and thus conform to the international regulatory standards for quality honey Bogdanov S. *et al* 1999 [11]. In ash content of honey samples from the study area ranged between 0.01 – 0.82. The result is consistent with Nuru Adgaba 1999 [21], who reported 0.1-1.0% ash content of honey samples of Ethiopia. This result is also agreed with findings of Tadesse Belie 2009 [23], Gebremedhin G. 2013 [17]. Therefore, the result of current study revealed that honey produced in South Omo Zone was floral honey which is good for consumption and industrial purposes.

Acidity of Honey

When the acidity becomes high, the honey becomes sour. The recommended acidity of honey is usually less than 40 meq acid/kg of honey. Our research result showed that the overall mean of honey sample acidity in the study area was 33.97 meq kg−1 ranged from 19- 96 meq kg−1 which was in accordance with the observation made by Nuru Adgaba 1999 [21], Gebremedhin G. 2013 [17].

Electrical Conductivity

Electric conductivity is the indication of ionizable acids and compounds in aqueous solution and it is a good criterion to know the botanical origin honey, the higher their content the higher the resulting conductivity. Almost all of the samples presented electrical conductivity values characteristic of nectar honey (≤ 0.8 mS cm-1) Bogdanov S. *et al* 1999 [11], with the overall mean of electrical conductivity was 0.41 mS.cm-1 ranges from 0.16 – 0.99mS.cm-1. The great differences between honeys in electric conductivity in the sample locations indicated existences of different flora species in each locality. Similar result has been reported for the honey produced from different floral sources at Bale of Ethiopia range 0.22 - 1.34mS.cm-1 with overall average value of 0.69mS.cm-1 Bekele Tesfaye *et al* 2016 [9], and Malaysia with mean 0.74 mS/cm and 0.41 mS/cm minimum and 0.79 mS/cm maximum values Bogdanov S. *et al* 2002 [12].

PH value of Honey

All honeys are acidic with a pH-value generally lying between 3.5 and 5.5, due to the presence of organic acids that contribute to honey flavor and stability against microbial spoilage Adebiyi FM *et al* 2004 [5]. This parameter has great significance during the extraction and storage of honey as it influences the texture, stability and shelf life of honey Chala Kinati, 2010 [13], the overall mean pH value results were 3.45 and with 2.7 minimum and 4.1 maximum values. This result agrees with the result of Bekele Tesfaye *et al* 2016 [9], Tadesse Belie 2009 [23].

HMF Contents of Honey

One of the most commonly monitored parameters for determining honey freshness and good practices by beekeepers are HMF Bogdanov S. *et al* 1999 [11], Marchini LC. *et al* 2007 [22], Adebiyi FM *et al* 2004 [5]. In fresh honey, HMF is present only in small amounts sometimes zero and its concentration increases with storage time and prolonged heating of honey. The hydroxyl methyl furfural (HMF) content of the honey samples analyzed in the present study ranged from 0.00 to 29.5 mg/kg with overall mean value 3.78 mg/kg.

Sugar Contents of Honey

Honey is a mixture of principally two reducing sugars namely glucose and fructose, giving it similar properties to invert syrup. This gives it the ability to remain liquid for long periods of time. Determination of sugars in honey is a quality criteria which is influenced by honey storage and heating and thus is an indicator of honey freshness and overheating. The study revealed that the overall mean of fructose content in the sample was 34.61% with in minimum 26.3% and maximum 40%. The average fructose content of the samples were in line with Teklit Gebregiorgis and Frehiwot Mekonen 2016 [24] and they all fall within the range of values reported by other scientists, the mean average glucose content of the sample was 30.91% with ranges of 27.3%-39.5% the current result was agree with Teklit Gebregiorgis and Frehiwot Mekonen 2016 [24], the average sucrose content of the honey sample was 1.96% which ranges between 0.80 – 6% this study result agree with Teklit Gebregiorgis and Frehiwot Mekonen 2016 [24], and the values obtained for sucrose contents of the honey samples were all within the limits of international standards that is the international norm established by codex almentarius commission requirement the good quality honey is not contain more than 5g/100g sucrose. And the overall average content of maltose was 1.36% with the minimum and maximum values was 0.3% 2.8%.

In addition to the sum of fructose and glucose other important factors that related to honey quality include the fructose/glucose ratio and glucose/water ratio. In this study, the fructose/glucose ratio and glucose/water ratio fall in the range of 0.76 to 1.31 and 1.2 to 2.09 with average values of 1.13 ± 0.12 and 1.57 ± 0.18, respectively. Fructose/ glucose ratio indicates the ability of honey to crystallize. White and Doner cited in Teklit Gebregiorgis and Frehiwot Mekonen 2016 [24], stated that even though honey has less glucose than fructose, it is the glucose that crystallizes when honey granulates because it is less soluble in water than fructose. When the fructose/glucose ratio is high, honey remains liquid. Honey crystallization is slower when the fructose/glucose ratio is more than 1.3 and it is faster when the ratio is below 1.0.

The glucose/water (G/W) ratio is considered more appropriate than the fructose/glucose (F/G) ratio for the prediction of honey crystallization. It has been stated that when the glucose/water ratio is <1.3 honey crystallization is very slow or even zero, and it is complete and rapid when the ratio is >2.0. Glucose, which is a major sugar in honey, can spontaneously crystallize from honey solutions in the form of its monohydrate. This sometimes occurs when the moisture level in honey is allowed to drop below a certain level; i.e., when the moisture content is very low.

It was stated earlier on that honey samples with (G/W) ratio of <1.7 are considered non-granulating while samples with ratios of ≥ 2.1 predicts rapid granulation. Also, according to Manikis and Thrasivoulou cite in Teklit Gebregiorgis and Frehiwot Mekonen 2016 [24], while glucose levels is a useful indicator of honey granulation, the G/W ratio appears to be one of the most effective indicator for predicting granulation tendencies of honey samples. Thus glucose/water ratio may be used both to predict and control granulation tendencies in honey.

Table 5: physico-chemical properties of honey

Parameters	N	Minimum	Maximum	Mean	Std. Deviation
Moisture content (%)	45	17.00	24.00	19.7556	1.50990
Electrical conductivity (mS/cm)	45	.16	.99	.4171	.25202
pH value	45	2.70	4.10	3.4511	.28811
Free Acidity(meq/kg)	45	19.00	96.00	33.9778	14.21825
Ash (g/100 g)	45	.01	.82	.1833	.20366
HMF (mg/kg)	45	.00	29.50	3.7800	7.19361
% of fructose	45	26.30	40.00	34.6133	2.66668
% of glucose	45	27.30	39.50	30.9089	2.70982
% of Sucrose	45	.80	6.00	1.9644	1.58217
% of Maltose	45	.30	2.80	1.3578	.88279
%fructose to glucose ratio	45	.76	1.31	1.1272	.11748
%glucose to moisture ratio	45	1.20	2.09	1.5738	.18645

Correlation between the physical properties of honey

Pearson correlations for moisture, electrical conductivity, ash, pH, and free acid are presented in the table 11. Significant ($p < 0.01$) correlations were observed between Ash and electrical Conductivity ($r = 0.955$); free acidity and ash content ($r = 0.418$); and free acid and electrical conductivity are significant at ($p<0.05$) ($r = 0.364$) Table 6. This was in agreement with the work carried out in Ethiopian honey (Abera Belay, *et al*, 2017) [3].

Color category of honey samples

The color of honey sample were measured in millimeters on a P-fund scale according to table 10 result shows below the results of the physicochemical analysis revealed that the colour of the honey samples varied from extra light amber, light amber, through amber to dark.

Table 6: color category of honey samples

Variables	Frequency	Percent
Dark	4	8.9
Amber	17	37.8
Light amber	16	35.6
Extra light amber	8	17.8
Total	45	100.0

Table 7: Correlation between the physical properties of honey

	Moisture content (%)	Electrical conductivity (mS/cm)	pH value	Free Acidity(meq/kg)	Ash (g/100 g)	HMF (mg/kg)
Moisture content (%)	1	.183	.024	.034	.088	.036
		.230	.875	.826	.563	.816
		45	45	45	45	45
Electrical conductivity (mS/cm)		1	.098	.364*	.955**	-.274
			.521	.014	.000	.069
			45	45	45	45
pH value			1	.134	.049	-.267
				.380	.748	.077
				45	45	45
Free Acidity(meq/kg)				1	.418**	-.138
					.004	.365
					45	45
Ash (g/100 g)					1	-.259
						.086
						45
HMF (mg/kg)						1

Conclusion

Majority of the respondents practice traditional beekeeping systems as well as to be used traditional way of honey storage materials. Beeswax production and processing were not known due to skill gap. Shortage of honeybee floras and predators were the most constraints of honey production whereas Market linkage problem, Skill gap to strain honey and beeswax production were the most problems of post-harvest handling of honey and intentionally beekeepers were not practice adulteration of honey. Produced honey from study area acquired honey physic-chemical properties standard like mean moisture content, Ash content, honey acidity, electrical conductivity, pH value, HMF, fructose, glucose, sucrose, maltose, F/G ratio, G/water ratio of honey was 19.75, 0.18, 33.97 meq kg−1, 0.41 mS.cm-1, 3.45, 3.78 mg/kg and 34.61%, 30.91%, 1.96%, 1.36%, 1.13 ± 0.12 and 1.57±0.18 respectively.

Recommendation

Technical training and awareness creation on improved beekeeping technologies and honey and beeswax processing should be given to beekeepers. Market linkage on honey marketing should be improved and regulate. In addition to this Beekeeping production constraint should be taken intervention methods.

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